Analysis of factors affecting post-harvest losses/wastage in mangoes to farmers in Makueni County.

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# Table of contents

ACKNOWLEDGEMENT ............................................................................................................. i

LIST OF TABLES .................................................................................................................. iii

LIST OF ACRONYMS ........................................................................................................... iv

INTRODUCTION ...................................................................................................................... 1

1.1 Background information ............................................................................................... 1

1.2 Problem statement ......................................................................................................... 3

1.3 Purpose of the study ....................................................................................................... 4

1.4 The hypothesis ............................................................................................................... 4

1.5 Justification of the study ............................................................................................... 4

1.6 Study area ....................................................................................................................... 5

1.7 Organization of the proposal .......................................................................................... 6

2.0 LITERATURE REVIEW .................................................................................................. 7

3.0 METHODOLOGY ............................................................................................................ 9

3.1 Data collection procedure and sampling design ............................................................. 9

3.2 Model used .................................................................................................................... 9

3.3 Variables included in the model .................................................................................. 10

4.0 RESULTS AND DISCUSSION ...................................................................................... 12

4.1 Socio-economic characteristics of mango farmers ....................................................... 12

4.2 Factors affecting post-harvest losses/wastage in mangoes ......................................... 13

5.0 CONCLUSION ............................................................................................................... 15

REFERENCES ...................................................................................................................... 16
LIST OF TABLES

Table 1: Variables included in the model

Table 2: Descriptive statistics for frequency and continuous variables

Table 3: Estimates of relationship of percentage lost/wasted in mangoes and farmers

Characteristics
LIST OF ACRONYMS

MOA - Ministry of Agriculture.

ASDS – Agricultural Sector Development Strategy.

GDP – Gross Domestic Product.

SPSS – Statistical Package for Social Sciences.

FAO – Food and Agricultural Organization.

KARI – Kenya Agricultural Research Institute.

WRI – World Resource Institute.

LAPSSET – Lamu Port and South Sudan Ethiopia Transport.

HCDA – Horticultural Crops Development Authority.

OLS – Ordinary Least Square.
1.0 INTRODUCTION

1.1 Background information

Agriculture in Kenya is referred to as to as the backbone of Kenya’s economy because of its annual contribution to GDP, it contributes about 24% and 27% of GDP directly and indirectly respectively (MOA, 2010). As a sector Agriculture is made up of different sub-sectors, inclusive of these are; subsistence crops, livestock, field crops and horticulture (ASDS, 2010). Over the years Kenya’s economy has been known to depend on agriculture and horticulture as a sector takes credit for this for the great strides and margin it contributes to Kenya’s agriculture. Horticulture has been identified with several benefits such as; improving the nutritional status of citizens of Kenya due to the consumption of different products it offers, it has also greatly factored as a source of income for small scale farmers and contributed to the country’s economy as a foreign exchange earner (Gor et al. 2012).

Being one of the major sub-sectors, horticulture accounts for about 33% of agricultural GDP and has an annual growth rate of about 15% to 20% annually (MOA, 2010). Horticultural crops are an important source of nutrients, vitamins and minerals essential for human well-being and health. Horticulture as an industry is mainly made up of vegetables, fruits, flowers, nuts, medicinal and aromatic plants. The sector attributes to about 10% of urban consumption. Fruits are the second biggest horticultural crops grown in Kenya (FAO, 2009), according to the previously sited literature vegetables dominate the sector followed by fruits and finally flowers. Flower production is majorly undertaken in large-scale production while fruits and vegetables are produced by small scale farmers, vegetables account for about 44.6%, fruits 29.6% and flowers 20.3% of the total produce related to horticulture (MOA, 2012). The industry plays different distinctive roles to the Kenyan economy; it is an important source of raw material for agro-processing industries, helps in poverty reduction, contributes in achieving food security and last but not least it creates employment and generate incomes (MOA, 2010).

Among all the fruits produced in Kenya; bananas, pineapples, and mangoes are the leading in terms of production. According to HCDA (2012), annual average production of bananas is about 1.2 million metric tons which accounts for about 15 tons/ha of national annual yield, mangoes on the other hand have an annual production of 295801 metric tons whereas pineapples accounts for
416218 metric tons annually. As illustrated by the previous statistics banana is the most widely grown fruit in Kenya, followed by pineapple and lastly mangoes. In 2010 about 35000 ha of land were under mango cultivation, in addition to this; mango production has had an annual growth rate of 26% annually since 2005. Approximately 98% of the total mangoes produced in Kenya are locally consumed whereas 2% goes to export (GOK, 2012). According to the Lamu port and South Sudan Ethiopia Transport (LAPSSET), a project launched by the Kenyan government to investigate on the opportunities and potentials of the mango industry in the Kenyan LAPSSET corridor; averagely, Kenyans consume about 12.7 kilograms of mangoes annually (GOK, 2012).

There are different types of mango cultivars grown in Kenya and they are subdivided into two major groups; the local and improved varieties (FAO, 2005).

Of the total amount of mangoes produced about 40% go to waste due to poor post-harvest handling especially during the peak seasons (KARI, 2004), this has effects on farmers income in the sector. Some farmers produce a lot of mangoes but only 60% of the fruits will be consumed and the remaining 40% goes to waste, about 20-25% of all mangoes produced in the world is wasted/lost due to poor post-harvest handling (Gor et al.2012). According to Gor et al. (2012), in showing how mango produce is utilized along the value chain the study illustrated; 30% of total fruits produced in Kisumu West District are for home consumption, 54% sold to brokers and the remaining 16% goes to waste, basically this kind of mechanism translates in different regions involved in mango production.

There are various reasons that revolve around this wastage faced in the mango value chain, poor quality, wrong variety as well as poor handling techniques, inadequate infrastructure, infestation by pests, diseases, immature harvesting, mechanical damage and excessive fruits in the market (Muchira et al 2006). Food loss and waste refers to plant or animal parts that are cultivated and harvested for consumption by humans but in the end they are not consumed but rather thrown away (World Resource Institute, 2013), world resource institute is a global research institution that in cooperation with different leaders conceptualize ideas into real action so as to enhance sustainability of our resources. They collect data, implement the change and then evaluate the results so as to scale their impact. Food loss in particular is later detailed as food that spoils, wilts or encounters a massive reduction in quality or doesn’t get to the end consumer for consumption.
Wastage on the other hand is further elaborated as good food quality that is good for human consumption but doesn’t reach the ultimate consumer because it is thrown away or discarded. This wastage and loss translates into different kinds of environmental and economic losses. Environmentally; wastage leads emission of greenhouse gasses and wastage of water and land because of inappropriate use which in turn diminishes vigor of the ecosystem. Economically there is a reduction in income to farmers i.e. wasted investment (money, time, labor and other resources at large) and also an increase in consumers’ expenses (World Resource Institute, 2013).

Eastern province accounts for over 50% of total mango production in Kenya and this is mostly dominated by small-scale farmers (Goret al.2012). However it is because of the recurrence nature of the “wastage” problem that I turned my focus to look deeper into this research topic. The target groups that I expect to benefit from my research are all the stakeholders involved in the mango value-chain and in particular those from Makueni county who over the years have had issues on how to control, losses and wastage in mangoes especially during the peak seasons, though other mango industry players from different destinations can also benefit from this study.

In regard to Makueni investment Forum, a forum held in 2010 in Wote at the County hall, where the main aim was to state/express clearly the different potential investment areas in Makueni county and to explore both national and international investment opportunities of the county as a whole. The forum recommends that there are investment opportunities still available in value addition, i.e. changing mango into juice. Cold storage facilities are important in transportation or storage of fruits so as to maintain quality and preserve them.

1.2 Problem statement.

Generally there is a lot of literature that illustrates a lot of losses/wastage in mangoes is caused by poor post-harvest handling and storage of the produce after harvest (Gor et al. 2012; MOA,2010; MOA, 2012; FAO, 2005). Most of this studies reflected that a lot of wastage in mangoes is attributed to post-harvest losses. However, focus is on the mango value chain as a whole that is from production to harvest. None of them has mainly concentrated on the factors that contribute to this loss specifically after harvesting. For instance Gitonga et al. (2006) from his study stresses on how to increase income for farmers through different agro-processing strategies and increased market access. Even though his study addresses agro-processing it still
introduces the idea of markets, it is in correspondence with this that, this study wants to concentrate on how factors of small-scale farmers contribute to losses after harvest.

1.3 Purpose of the study
The purpose of this study is to analyze factors affecting post-harvest loss/wastage in mangoes to farmers in Makueni County.

The specific objectives of this study are;

i. To assess socio-economic characteristics of mango farmers’.
ii. To examine factors affecting post-harvest losses/wastage in mangoes.

1.4 The hypothesis

i. Factors such as; age, level of education and access to markets do not affect post-harvest losses.

1.5 Justification of the study
This study revealed meaningful information depicting various factors affecting post-harvest losses/wastage in mangoes, exclusively in Makueni County. This is considered beneficial to both the agricultural sector and mango processing industries in Kenya, and can be of importance to all the players in the mango value chain, including;

Policy makers who will implement appropriate policies in the agricultural sector that will help focus attention in reduction of wastage or losses in mangoes. They would also be guided on making sound decisions on which alternatives to prioritize in case of implementation.Mango farmers in Kenya may use this information on seeking various alternatives that will help them reduce wastage in mangoes and therefore increase its shelf life this can be beneficial in terms of giving them allowance to bargain for a good market price and also could add value on the product and access new markets hence increase in income.

The Kenyan and other African governments will also benefit from this information by getting to know how different factors that contribute to losses/wastage in mangoes and come up with appropriate mechanisms to control this lose, primarily to states that are large mango
The study is also of importance to institutions that are executing projects with focus on the mango value chain and exclusively focusing on how to reduce post-harvest losses/wastage, such as FAO, KARI and Bio vision.

1.6 Study area

Makueni is one of the Counties in eastern Kenya, it was arched from Machakos and it forms part of Ukambani area. The area is characterized by volcanic land formation inclusive of these are Kilungu and Chyullu hills. Lower side of the district is composed of grassland and this makes the area conducive for ranching whereas the northern hilly part has a great potential in terms of food production. The district receives two rainy seasons; long rains which are experienced in March and April and short rains between November and December. It receives approximately 150-600 mm per annum and the lower parts experience high temperatures that range from 12-28°C. It has area coverage of 8008.8kms.

Makueni County has a total population of 884,527 people and out of this 51% are female and 49% male. The main economic activities practiced in this area include; agriculture, beekeeping and limited dairy farming. Major agricultural products produced are; mangoes, watermelons, paw paws, maize, cowpeas, pigeon peas and livestock keeping. Eastern Kenya accounts for over 54% of total mango production in Kenya (Gor et al. 2010), Makueni being one of the Counties in Eastern Kenya contributes to this production hence its relevance as a study area in this study.

Fig: shows Makueni location.
1.7 Organization of the project.

Subsequent chapters of this project are organized as follows; chapter two gives a review of literature; chapter three depicts the methods used in the study, chapter four gives a detailed discussion of results, chapter five concludes the project and finally chapter six gives a list of references.
2.0 LITERATURE REVIEW

Martine (2013) highlights that food waste is a sensitive issue considering the fact that hunger cases are still prevalent among poor people. Furthermore he suggests that about one third of the total amount of food produced globally is lost through wastage and losses. The study compares other food types to vegetables, fruits, roots and tubers in terms of losses and the latter suffer massive loses/wastage as compared to the former. The loss is attributed to about 40-50% in the entire supply chain. In addition to this the study stresses that in low income countries a lot of edible food is lost during production and post-harvest processes. However, the study only focused on impacts of food losses to consumers and does not put producers (farmers) into consideration.

According to Oswald et al. (2011), mango farmers in Tanzania who are organized in associations and are trained on different methods on how to increase shelf life and also transfer their produce into different by-products realize higher incomes from farming. The reason behind this being, they are able to have time to negotiate on better market prices due to reduced rate of perishability of their produce. Khuda et al. (2006) from his study, says that mangoes are highly perishable in nature. For this reason mangoes call for proper storage, packaging and transport facilities. Nevertheless the study further illustrates that such kind of infrastructure is not available to small scale farmers and in conclusion it says if the mango sector is provided by the relative infrastructure it will realize greater benefits.

Julie (2000) in analyzing the role of agribusiness in development, identified benefits of agribusiness enterprises in the local areas. The study found that a lot of gains are captured by value addition that is brought about by post-harvest activities. The study further showed that, for each gain captured due to value addition can be used to enhance local enterprises hence enhances stability.

Gitonga et al. (2006), in assessing how to enhance income of small scale mango farmers’ in Kenya through agro-processing and increased market access uses a statistical package for social sciences (SPSS) model. The study found that only 1.3% of farmers’ stored their mangoes so as to reduce its perishability. In addition to this the study also revealed that a lot of post-harvest losses
are due to improper harvesting methods and damage caused by pest and diseases. The study concluded that there is a great need to train farmers on processing of their produce so as to reduce post-harvest losses and also increase markets for value added products this will in turn increase income levels for farmers.

Lawal et al. (2009) used a gross margin analysis to determine the profitability of value addition in cashew nut to farmers in Nigeria. Results showed that; for farmers who indulged in value addition there business progress was as follows: gross revenue- 566.42, gross margins- 495.55 and net incomes-487.26. These were higher returns compared to farmers who did not practice value addition in their nuts whose returns were; gross revenue- 378.28, gross margin- 318.83 and net income- 304.49. The two cases illustrated a difference of 188 in terms of profit margin which was in favor of farmers who added value. In conclusion the study said that value addition led to an increase in incomes for cashew nut farmers in Nigeria, additionally it states a double increase in incomes to farmers who added value as compared to those who did not.

Majority of past studies have assessed the impact of various means of enhancing incomes to small-scale farmers through reduction of losses and wastage of their produce. However, none of these studies has concentrated on the reduction of losses and wastage at the post- harvest stage and the factors that contribute to this loss. Therefore this gap justifies the reason for the study to provide more information on the factors that contribute to post-harvest losses/wastage in mangoes, a case study in Makueni County.
3.0 METHODOLOGY

3.1 Data collection procedure and sampling design

Data for the study was collected with the aid of semi structured questionnaires that were used to gather respondents’ opinions about the variables in question. Primary data was collected through face to face interviews from different households in Makueni County. Both qualitative and quantitative data was collected in the study to answer different questions, attributes like gender, market access, access to extension services and farmer groups were collected for the qualitative part among many others. Whereas for quantitative part, data on income levels, total harvest, farm size and age among other different variables were collected.

Purposive sampling was used to select Makueni County based on a report, MOA, (2005) Eastern Kenya produces highest volume of mangoes in Kenya. Respondents in the study were selected on a random basis using the Central Limit Theorem which states that as the number of occurrences\( (n) \) increases, the expected results move closer to the actual results. Therefore any sample size that is greater than 30 is justified to infer population characteristics from the sample selected. A total of 31 respondents were selected and interviewed on mango production and questions related to wastage along the mango value chain. Data analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0.

3.2 Model used

Ordinary least square (OLS) regression model was used in the study to analyze the relationship between percentage loss/wastage in mango production and the socio-economic variables. The model is normally used to show a linear relationship between the dependent variable and the independent variable and it stated as follows;

\[ Y = \alpha_i + \beta X_i + u_i \]  

Where:
\[ Y = \text{percentage losses/wastage in mangoes (dependent variable).} \]
\[ \alpha_i = \text{Constant (other factors which were not include in the model but affect the dependent variable)} \]
\[ \beta = \text{Co-efficient (to be determined by the variable)} \]
\[ X_i = \text{Variable (independent variable)} \]
\( u_i = \text{Error term.} \)

### 3.3 Variables included in the model.

A number of variables were included in the model so as to answer the study objectives and these included:-

**Table 1: Variables used in the model**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description of the Variable</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Szefrm</td>
<td>Size of mango farm (acres).</td>
<td>_</td>
</tr>
<tr>
<td>Membrincoperative</td>
<td>Co-operative Membership (0=no, 1=yes)</td>
<td>_</td>
</tr>
<tr>
<td>Vstbyxtensnoffcer</td>
<td>Visited by an extension officer (0=never, 1=visited)</td>
<td>_</td>
</tr>
<tr>
<td>Dsttmkt</td>
<td>Distance to the market</td>
<td>+</td>
</tr>
<tr>
<td>Higedulvl</td>
<td>Highest education level (1 =Secondary and above)</td>
<td>_</td>
</tr>
<tr>
<td>Frmnxprnc</td>
<td>Farming experience in years (0=below 5, 1=5 and above)</td>
<td>_</td>
</tr>
</tbody>
</table>

Size of farm was included in the model because of the variance in the sizes of land among farmers and it was expected that farmers with large land sizes will have high production and therefore be motivated to invest in ways of increasing shelf life of their produce so as to reduce losses and wastage. Membersinco-operative was used because it was expected that, farmers who were in groups are more organized and have access to different trainings and capacity building excursions and this would help to increase the amount of reduced losses.

Visitby extensionofficer illustrates those farmers who have access to extension services as compared to those who do not have and it was expected that farmers with access to extension services will have reduced losses due to practicing what they learn from extension officers. Distance to market was included to capture how far or close the farmer is from the market and it was expected that those farmers who are nearer to the market would have few losses/wastage as compared to those farmers who are far from the market. This is because high distances means the fruits can be injured during transportation due to poor roads and this will act as a source of damage.
High education level is supposed to capture those farmers who have an education level of secondary and above as compared to those below secondary. Farmers with a higher education level are expected to have fewer losses as compared to the others and this is because an increase in education level should mean more skills and also they have come across different information sources on how to reduce losses/wastage in mangoes. Farming experience is used to capture those farmers who have been in mango production for 5 and above years as compared to new farmers in the system, it is expected that experienced farmers will have reduced losses as compared to non-experienced farmers. This is because experienced farmers have been with the losses phenomenon for longer periods and are expected to have a plan on how to counter-attack any problem that may lead to losses in case it surfaces.
4.0 RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of mango farmers

According to Table two, all respondents interviewed were mango farmers, majority of these were male. A larger percentage comprised of more experienced farmers with five and above years in mango production and 58 percent of the total respondents had an educational level of secondary school and above. This indicates that majority of female farmers are not encouraged to indulge in mango farming, this may be due to the bulkiness of the fruits and long distance to access the markets which make transportation an issue. Furthermore, mango farmers in this area are also well educated since more than half of the respondents had an education level of secondary and above. This illustrates that; with a little incentive and a lot of knowledge delivery to the farmers in this County, the total yield per farm can be increased and similarly they can be able to adapt ways that will help in reduction of losses. The table also indicates that the mean age of farmers is 40 years with an average income level of Ksh. 13,100 per month this illustrates that majority of farmers are still young and have an income level that can be used to invest in mango production. 63 percent is the number of farmers who were visited by extension officers over the last production season. Farmers who were visited had minimal losses compared to those who were not visited hence this results show that there is need to increase the number of extension officers so as to be able to reach as many farmers as possible.

According to Table two below, the mean farm size for each farmer is 2.7 acres and the total mean harvest is 67 bags. This indicates that the average yields per acre per farmer is 25 bags, with the right support in terms of extension services, credit facilities, subsidies and farmer trainings the average yield per acre for each farmer can be 25 bags. The table shows that the mean distance to the market for each farmer is 16 kilometers per farmer this shows that there is need to invest in infrastructure or methods that will help increase shelf life of mangoes and maintain its quality before it reaches the market. The distance is large compared to the poor roads in the county and this can be associated with some of the losses exhibited by farmers’. The table also shows that 60 percent of mango farmers’ in the area are in cooperatives this is a good figure and also shows a level of organization among farmers. This means that resource distribution in terms of inputs, knowledge, processing services and many other resources can easily be distributed through the cooperatives.
Table 2: Descriptive statistics for frequencies and continuous variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean size of farm (acres)</td>
<td>2.7 (1.6)</td>
</tr>
<tr>
<td>Mean total harvest (bags)</td>
<td>67.5 (73.6)</td>
</tr>
<tr>
<td>Mean distance to the market (kilometers)</td>
<td>16.3 (17.5)</td>
</tr>
<tr>
<td>Mean income level</td>
<td>13100 (6965.3)</td>
</tr>
<tr>
<td>Mean age in years</td>
<td>40.4 (6.0)</td>
</tr>
<tr>
<td>Farming experience (% above 5 years)</td>
<td>58.1</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>58.1</td>
</tr>
<tr>
<td>Highest education level (% above secondary)</td>
<td>58.1</td>
</tr>
<tr>
<td>Visited by an extension officer (% Yes)</td>
<td>61.3</td>
</tr>
<tr>
<td>Cooperative membership (% Yes)</td>
<td>60</td>
</tr>
</tbody>
</table>

Note: Standard deviations for continuous variables are in parentheses.

4.2 Factors affecting post-harvest losses/wastage in mangoes

Regression results from Table three show that; four variables are significant except for membership in co-operatives and farming experience. Constant term refers to other factors that were not included in the model but affect the dependent variable. There is an inverse relationship between farm size and the percentage lost/wasted whereby an increase in farm size by one acre reduces percentage lost by 20 percent, similar to the earlier prediction that it will have a negative effect on losses. This can be explained due to the fact that farmers’ with large land tracts may have invested in cooling systems or have developed processing technologies to increase shelf life of their produce. As expected earlier an increase in the number of visits by extension officer reduces the percentage of mangoes lost/wasted by 69 percent. This result can be best explained by the fact that extension officers might be advising farmers on better ways of increasing shelf life of their produce and proper post-harvest control methods and this translates to reduced losses. The fact that this happens if there is an increase in the number of visits illustrates that; by
follow-ups from extension officers it helps the farmer get the skill and be more anxious to practice whatever they are being informed about.

Table 3: Estimates of relationship of percentage lost/wasted in mangoes and farmers characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>coefficient</th>
<th>standard error</th>
<th>significance (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.95</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td>Szefrm</td>
<td>-0.20</td>
<td>0.09</td>
<td>0.03</td>
</tr>
<tr>
<td>Membrincoperative</td>
<td>0.01</td>
<td>0.31</td>
<td>0.97</td>
</tr>
<tr>
<td>Vstbyxtensnoffcer</td>
<td>-0.695</td>
<td>0.30</td>
<td>0.03</td>
</tr>
<tr>
<td>Dsttmkt</td>
<td>0.014</td>
<td>0.01</td>
<td>0.08</td>
</tr>
<tr>
<td>Higedulvl</td>
<td>0.507</td>
<td>0.27</td>
<td>0.08</td>
</tr>
<tr>
<td>Frmnxprnc</td>
<td>-0.057</td>
<td>0.28</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Source: Field survey data, 2014

An increase in distance by one kilometer increases percentage of mangoes lost or wasted by 1.4 percent, this result takes the same point of view with the predicted results in the model. This maybe a result of poor roads which lead to a lot of damage caused to the mango during transportation to the market hence farmers who are further from the market experience more losses than those nearer the market. Bruises caused to mangoes during transportation provide potential entry points for damaging pests which will damage the fruit leading to losses. There is a positive relationship between level of education and quantity of mangoes lost/wasted. Whereby an increase in a single year in secondary and post-secondary school will increase the loss by 50 percent, this can be justified by saying as an individual becomes more educated they tend to indulge into a lot of enterprises/activities as compared to less educated people, this in farming translates to limited attention to a particular farming enterprise and in mangoes lack of attention will lead to an increase in losses.
5.0 CONCLUSION

The aim of the study was to analyze factors affecting post-harvest losses/wastage in mangoes and to determine socio-economic characteristics of mango farmers, ordinary least square regression model was used in attainment of these objectives. The results showed that; size of the farm, distance to the market, visit by extension officers and education level were the significant factors that contributed to losses/wastage in mangoes. From the results it is important to encourage mango farmers to invest in cooling technologies and processing strategies so as to increase shelf life of the produce. Extension services should also be encouraged and increased to mango farmers because this will encourage farmers’ to continue practicing whatever they learn from extension officers and this will ensure a decrease in mango losses. There is also need to better develop our infrastructure system especially the roads so as to reduce the time taken to transport mangoes from the farm to the market and also to reduce bruises caused on the mango fruits due to pot holes that causes injuries on the fruits which serve as potential sources of rotting to the fruit. Farmers should also be encouraged to concentrate in whatever enterprises they indulge in even though they are practicing diversification. This will lead to realization of greater benefits because they can identify minor changes in their farming activities as compared to times when they are only available partially.
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